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Telluric Globe - 1852

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A
MANUAL
FOR
JOSLIN'S
NEW
SOLAR TELLURIC GLOBE,

DESIGNED FOR THE USE OF

FAMILIES, SCHOOLS AND ACADEMIES.

Boston:
PUBLISHED BY G. JOSLIN.
1852.

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INTRODUCTION.

Every person is aware in attempting to acquire an understanding of the principles and relations of the parts of any complicated piece of machinery, by a *verbal* description, that he finds it exceedingly difficult to obtain a correct idea of the principles which govern it, whereas by a simple model, or the machine itself, upon which he could direct his eye, he would soon comprehend all its various parts, and the relations that each sustains to the other, with apparent ease.

The same difficulty presents itself in attempting to acquire an understanding of the motions of the solar system, which differs very little in principle from a machine, except in point of magnitude.

Every teacher must also be aware of the exceeding difficulty he encounters in attempting to explain to children, whose minds are not accustomed to thought, the various motions of the earth, and its consequent phenomena, so that they can easily comprehend them, which is quite necessary before they can make much progress in the study of Geography. This difficulty has been almost entirely removed by the production of Joslin's *Solar Telluric Globe*, an examination of which will satisfy any one of this fact.

This globe differs from all others in its general arrangement, its strength and durability of material, its superior workmanship, combining both the geography of the earth, and its diurnal and annual motions, by which are caused the changes of the seasons, day and night, and many other phenomena, which renders it far superior to any other now in use. It is in fact a model of the earth and sun, showing their motions, and illustrating the relations which each sustains to the other. In a single half hour a child may be taught by this globe what few persons learn during their lives.

Being aware of its great utility both in the family and school, and knowing that many neither understand the principles which it illustrates, nor the methods of explaining them by its use, has induced the preparation of this little work to accompany it, and the author has endeavored to arrange the various problems, and to explain them in such a manner, that any one of common understanding may easily comprehend, and also be able to explain them to their children or to others; and he trusts that teachers will find it exceedingly useful to them when engaged in teaching the science of geography.

If he has succeeded in removing any of the difficulties in the way of acquiring a knowledge of that most useful science, Geography, and by that means made it more attractive to the youthful mind, he will feel that he has accomplished a desirable end.

PART I.

DESCRIPTION OF THE GLOBE.

In order to understand the process of working problems with a globe, it will be necessary to learn the names of the different parts and their various uses. It must also be constantly borne in mind that the terms, *down* and *up*, are only *relative* terms, and that *towards* the centre of the globe always represents *down*, and *from* the centre, *up*, whatever may be the position of the place on its surface.

The large ball is called the *globe*, or sphere, and represents the form of the earth, which is about eight thousand miles in diameter, and twenty five thousand in circumference. Upon its surface are drawn the various natural divisions of land and water, continents, islands, capes, mountains, oceans, lakes, bays, rivers, &c.; it also represents the political divisions of countries, and the lines of latitude and longitude. The iron rod which passes through the centre of the globe, upon which it turns, is called its *axis;* it is inclined 23½° from perpendicular, and always points in the same direction, whatever may be the position of the globe in regard to the sun; the upper end of the axis is the *north pole* and the lower end the *south pole;* around the north pole, upon the globe, is a *dial* or hour circle, divided into twenty four parts, which represent the 24 hours of day, and are marked with the Roman numerals corresponding with the dial of a clock. The index attached to the north pole is called the *dial index.*

The brass circle around the globe is called the *day circle* and is graduated into degrees and numbered from 0° to 90°. It represents the boundary line between day and night; sunlight or day being on its graduated, and night on its opposite side. It is also marked *east* and *west,* which represent sunrise and sunset.

The brass ball elevated above the centre of the base, and around which the globe moves, represents the *sun* which is here made small, and located near the globe for convenience, although the sun's real distance from the earth is 95,000,000 of miles, and its diameter 886,000 miles.

That piece through which the lower part of the axis passes, and to which the day circle is attached, being pointed at its opposite end, and moving round upon the centre post of the base, and having a set screw to render it immovable when desired, is called the *calendar index;* it points to the day of the month upon the calendar, and to the degree of the signs of the zodiac.

Upon the upper surface of the base is represented the *calendar* and the *signs* of the *zodiac*; the *exterior* circle being divided into parts corresponding to the months and days of the year, and the *interior* circle into signs and degrees with their corresponding names and characters. This represents the plane of the ecliptic or orbit of the earth round the sun.

To understand what is meant by the plane of the ecliptic, you must first understand what is meant by a plane. A plane may be real or imaginary. Any flat surface is a real plane; remove that surface and the place it occupied, will be an imaginary plane. The plane of the ecliptic is an imaginary plane, in which the orbit of the earth lies.

The rotation of the globe on its axis from West to East, is called its *diurnal* or daily motion. Its motion round the brass ball, which represents the motion of the earth round the sun, is called its *annual* motion, because it requires a year to perform one revolution.

The lines upon the globe running through the poles, at right angles with the equator, represent divisions of longitude, and are 15° apart, and correspond to the hours of time, dividing the globe into twenty four equal parts. The graduated line around the globe, being located at equal distances from either pole, is called the *equator*. The lines on each side of the equator, running parallel to it, are called *parallels* of latitude, and are at distances of 10° from each other.

The two *dotted* parallels of latitude, located on each side of the equator, at a distance of 23½° from it, are called the *tropics*, and enclose between them that part of the earth over which the sun is vertical during some parts of the year, and is called the burning or *torrid* zone. The tropic of Cancer is on the *north* side of the equator, and is so called because the sun when vertical at this line, is just entering the sign of the zodiac, Cancer. The *tropic* of Capricorn is on the *south* side of the equator, and is so named because the sun when vertical at this line is just entering the sign Capricornus.

The *dotted* circles situated at a distance of 23½° from either pole, are called the *polar circles*, and enclose those parts of the earth which have no sunlight during some portions of the year. They are called the *frigid* or frozen zones. The north polar circle is called the *arctic*, and the south the *antarctic* circle.

The remaining parts of the earth located between the tropics and the polar circles, are called the *temperate* zones. They each embrace a space around the earth 43° in breadth, and complete the natural divisions of the earth's surface into five *zones* viz.: one *torrid*, two *temperate*, and two *frigid*.

The reason why the zones are located as above described, is because the axis of the earth is inclined at an angle of 23½° to the plane of its orbit. Had the earth's axis inclined only 10° to the plane of its orbit, the tropics would have been located at a distance of only 10° from the equator, and the torrid zone would have been only 20° in width, instead of 47°. The arctic circles would also have been only 10° from the poles, and the frigid zones would have been enclosed within them, leaving for the temperate zones a space of 70°. Had the axis of the earth been perpendicular to the plane of its orbit, there would have been *no natural* divisions of the earth into zones.

The figures on the north side of the equator, express the degrees of longitude, and are reckoned from the meridian of Greenwich, east and west, from 0° to 180°.

The Roman letters on the south side of the equator represent the hours of time, and correspond to the degrees of longitude. The figures between the letters express the minutes of time.

QUESTIONS.

What part is called the globe?
What is understood by the terms *up* and *down* in relation to a globe?
What is understood by the *axis* of the globe?
How many degrees is it inclined from a perpendicular?
Does it change its direction in moving round the sun?
What part of the axis is called the north pole?
What part the south pole?
Where is the dial situated?
What do its *divisions* represent?
Where is the *day circle*, and what does it represent?
On which *side* of the day circle is *day*, and which *night?*
What does the *brass ball* represent?
What part is called the *calendar index?*
What is its use?
Where is the *calendar* situated?
How is it divided?
Where is the zodiac, and how is it divided?

What does the zodiac represent?
What is understood by a real, and what by an imaginary plane?
What is understood by the earth's diurnal motion?
What by its annual motion?
What are lines of longitude, and how are they drawn upon the globe?
Where is the equator located?
Why is it so called? What do the Roman letters represent?
What do the figures express? What are parellels of latitude?
Where are the tropics, and what are they called?
Where are the polar circles, and what are they called?
Where is the torrid zone, and how many degrees wide is it?
Where are the temperate zones, and how wide are they?
Where are the frigid zones, and what space do they occupy?
What causes the natural division of the earth into zones?
What condition is necessary for a change in the extent of the zones?

PART II.

SOLUTIONS OF PROBLEMS.

As the earth is not always in the same position with regard to the sun, owing to the inclination of its axis to the plane of its orbit, it becomes desirable to find a means by which we can see and understand its true position, for any given time. This may be accomplished by

PROBLEM I.

To find the position of the earth, in its orbit, as regards the sun, for any given day in the year.

Find upon the calendar the *given day*, and bring the calendar index to that day, and tighten the set screw. The globe will then represent the required position of the earth. It will be observed that the globe occupies a different position for every day in the year.

QUESTIONS.

What is the position of the earth at the 21st March? 10th of May? 22nd of June? 1st of Aug.? 20th of Sept.? 22nd of Dec.? 10th of Feb.?

Latitude is the distance of any place from the equator, and is called *north* or *south* latitude, accordingly as the place is situated north or south of that line, and is reckoned in degrees, from 0 to 90°.

Longitude is the distance of any place *east* or *west* of some *standard meridian.* It is measured on the *equator*, and is reckoned from 0° to 180°, and is called *east* or *west* longitude, accordingly as the place is located east or west of the standard meridian. The meridian usually taken as the standard, is that of the Observatory of Greenwich, in London, and is marked on the equator with a 0°.

That the science of Geography may be successfully studied, it is necessary to know the *latitude* and *longitude* of all places upon the earth. A method of finding it is furnished by

PROBLEM II.

To find the latitude and longitude of any given place.

Bring the calendar index to the 20th of March, and the north pole will be directly under that point of the day circle marked 90°, and fix it there by the set screw.

Find the given place upon the globe, and bring it directly under the graduated edge of the day circle, and read its *latitude* from the graduation immediately over the place, and its *longitude* upon the *equator* directly under the day circle.

QUESTIONS.

What is the latitude and longitude of Boston? New York? New Orleans? St. Petersburgh? Nankin? Cape Verde Island? Isle of Bourbon? Cape Farewell?

Every person understands what is meant by Summer and Winter, Spring and Fall, or the changes of the seasons as they are called, but few understand the causes that produce them. A method of explaining this curious phenomenon is furnished by

PROBLEM III.

To show that the changes of the seasons are produced by the inclination of the axis of the earth to the plane of its orbit.

Bring the calendar index to the 21st of March; then turn the base until the axis of the globe points to the *north star*, or to some *object* upon the ceiling representing it. It will then be seen by turning the globe on its axis, that the sun is vertical at the *equator*, and shines from pole to pole. This position represents the *spring season* or *vernal equinox*.

Now move the calendar index forward, through April and May, to the 21st of June, and it will be seen that the axis of the globe still points to the same *object* upon the ceiling, but that it has assumed a different position with regard to the sun, which seems to have approached the north pole, and is vertical to a parallel on the globe 23½° north of the equator. This position of the globe represents the *summer season* in the *northern,* and *winter* in the *southern* hemisphere, the sun being at its *summer solstice.* The difference of temperature at the different seasons, is caused by the more vertical direction of the sun's rays,

Again move the calendar index to the 23rd of September, and it will be observed that the sun has receded, and is again directly over the *equator*, and shines from pole to pole, as on the 21st of March ; but that the axis of the globe, having again changed its position in regard to the sun, still points to the same object on the ceiling. This position represents the *fall season* or *autumnal equinox.*

Move again the calendar index to the 22nd of December, and notice that the sun has continued to recede, and seems to have approached the *south pole,* and is vertical to a parallel of latitude 23½° south of the equator, while the axis still retains the same direction. This position represents the *summer season* in the *southern,* and *winter* in the *northern* hemisphere, the sun, at this time, being at its *winter solstice.*

Now move the calendar index to the 21st of March, and observe that the globe has completed one revolution round the sun, and that its axis still occupies its original direction. Had the axis of the earth been *perpendicular* to the plane of its orbit, there could have been no change of seasons, as the sun would have been *constantly vertical* at the equator. In order to show when it is *Summer*, and when *Winter* at the poles, and why it is Summer at one pole and Winter at the other at the same time, you have only to move the globe round the sun, and observe that when the *north pole* is on the *sun side* of the day circle, it will be *Summer* in the *northern hemisphere*, and when on the *opposite* side of the day circle, it will be *Winter*. The same is true with regard to the south pole. The season of the year, or day of the month for any position of the globe, may be read from the calendar at the index.

That the days and nights vary in length at *different* seasons of the year, is the common observation of every one, and that they vary in length in *different* parts of the earth at the *same* season, is no less true.

This may be illustrated by

PROBLEM IV.

To find the length of a day or night for any given day in the year, at any given place on the earth.

Bring the index to the given day upon the calendar; find the given place upon the globe, and bring it directly under the west side of the day circle; set the dial index at XII, then turn the globe eastward until the given place comes directly under the east side of the day circle, and read from the *dial* the number of hours that have passed under the index, which will be the length of the day. To measure the length of night, count the time from the dial, while the given place is passing *behind* the day circle in the same manner as for the day; or subtract the length of the day from 24 hours, and the remainder will be the length of the night.

It will be observed that at the 21st of March, and 23rd of September, the days and nights are each just XII hours long at every place on the earth, and also that they are the *same* length at the *equator*, for *every* day in the year, but that at every *other* place, they vary in their length according to the *latitude* of the place and *time* of the year.

At all places within the artic or frigid zones there is either constant day, or constant night, during some part of the year, and the length of time during which this condition lasts, depends upon the *distance* of the place from the pole. At the poles there is constant day or night six months in succession. Although the days vary in their relative length, for every degree of latitude, yet every *part* of the earth receives the *same* length of *sunlight* during the year.

This variation in the length of days, is caused by, and dependent upon, the same condition that produces the changes of the seasons, viz: the inclination of the earth's axis to the plane of its orbit.

QUESTIONS.

What is the length of the day in Boston at the 10th of April? 20th of May? 22nd of June? 15th of August? 20th of September? 1st of November? 22nd of December? 10th of February? What will be the length of the days at St. Petersburgh, at the above dates? at Ceylon? Isle of Bourbon? Cairo? Stockholm? Cape Verde? St. Diego? Mexico? Cape Farewell? North Cape? San Francisco? Washington?

It is well known that the *relative* length of day and night, changes more rapidly at *some* seasons than at *others*, and that it also changes more rapidly in places situated in *high*, than in *low* latitudes.

This will be explained by reference to

PROBLEM V.

To show that the relative length of day and night changes more rapidly at some seasons than at others, and also that it changes more rapidly in high than in low latitudes.

Bring the calendar index to the 1st of February, and measure the length of a day and night at Boston, or any other place you please. Then move the calendar index to the 1st of March, and there measure the length of a day or night, and note down the *difference* in the length of the days, measured at the different months; then move on to the 1st of April, and measure again, and so on through *every* month in the year, always measuring at the *same* place, and noting down the difference between the measurements. Now examine your notes, and you will observe that the relative length of day and night, changes more rapidly during the months of February, March, April, August, September, and October, than during the months of May, June, July, November, December, and January.

By measuring *one* place, near the equator, as above described, and *another* place in high latitude, and comparing the difference, you will notice that the relative change of day and night is more rapid at places situated in *high*, than in *low* latitude.

Knowing that the sun rises and sets at different hours of the day, at different places, in different seasons of the year, a means of determining the hour of sunrise and sunset, is desirable and will be furnished by

PROBLEM VI.

To determine at what time the sun will rise or set, on any given day in the year, at any given place on the earth.

Place the calendar index at the given day and fix it there by the set screw; then find the given place on the globe, and bring its meridian of longitude directly under the sun; this position of the place will represent noon, and accordingly, set the dial index at XII; then turn the globe *westward* until the given place comes directly under the day circle, and the *dial* index will point to the hour of sunrise; or turn the globe *eastward* until the place comes under the day circle, and it will point to the hour of sunset. The *apparent* motion of the sun and stars, from east to west, it will be seen, is caused by the *real* motion of the earth from west to east.

QUESTIONS.

At what time will the sun rise or set on the 21st of June, at Stockholm? London? Boston? Mexico? Quito? Cape Horn? At what time will the sun rise and set at the above places on the 25th of August? 22nd of September? 10th of November? 22nd of December? 15th of January?

It may be desirable to know at what time the sun will be vertical at any given place within the torrid zone.

This is shown by

PROBLEM VII.

To find when the sun will be vertical at any given place in the torrid zone, or how many degrees north or south of the equator it will be for any given day in the year.

Bring the meridian of longitude of the given place directly under the sun, then holding the globe in this position with one hand, move forward the calendar index with the other, until the given place is brought to a position where the sun will be vertical to it, then read from the calendar at the index, the required time of year. In order to find how many degrees north or south of the equator the sun will be for any given day, bring the calendar index to that day, then turn the globe until the graduated meridian of longitude comes directly under the sun, and read from it the number of degrees of latitude.

QUESTIONS.

On what days will the sun be vertical at Cuba? at Ceylon? Quito? Cape St. Rogue? St. Helena? Isle of France? Rio Janerio? Mexico? At what places will the sun be vertical on 20th of October? 15th of November? 22nd of December? 1st of March? 1st of February? 10th of May? 21st of June? 10th of August? 1st of September.

It is a fact well known, that at some seasons of the year, some parts of the earth's surface have constant sunlight, while other parts have no sunlight. A means of determining when this phenomena will occur, and at what places, will be found by consulting

PROBLEM VIII.

To show what parts of the earth have constant day, or constant night, and how long this condition lasts.

Bring the calendar index to the 22nd of June, then all those parts of the globe around the north pole, which do not pass *behind* the day circle, when the globe is turned upon its axis, will have constant day, or sunlight; and all those parts around the south pole, which do not pass *forward* of the day circle, will have constant night, or no sunlight. At the 22nd of December the reverse of this takes place, when all places situated in the *north* frigid zone will have constant *night*, and in the *south* constant *day*.

How long this condition will last, for any given place, may be determined by bringing the calendar index to such a position, that the given place will cease to pass behind the day circle, when the globe is turned upon its axis. Then notice the time at the index upon the calendar, and move forward the index until the given place begins to pass behind the day circle, when the globe is rotated, and read from the calendar how long the given place has had constant day. Constant night is determined in the same manner, by finding how long a given place will remain behind the day circle.

QUESTIONS.

How long will constant day continue at Spitzbergen? New Siberia? Icy Cape? Disco Island? North Cape? How long will these places have constant night?

The light which precedes sunrise, and succeeds sunset, called *twilight*, is caused by the refraction, or bending of the sun's rays, in passing through the atmosphere, and extends back 18° from the line of direct sunlight. It continues longer at some seasons of the year than at others, and it also varies in different locations. A means of determining the length of twilight, and the cause of its variations, will be found by referring to

PROBLEM IX.

To determine when evening twilight ends and morning twilight begins, at any given place, for any given day in the year, and why it is longer in summer than winter, and what parts of the earth have twilight all night.

Place the calendar index at the given day of the year, and bring the meridian of the given place directly under the sun; then set the dial index at XII. Now turn the globe eastward until the given place has passed 18° behind the day circle, and read from the *dial* the time when evening twilight ends; continue to turn the globe in the same direction until the given place comes within 18° of the other side of the day circle, and read from the dial the time when morning twilight begins.

For measuring the distance of 18°, take a slip of paper two inches in length and apply it to the equator lengthwise, and take a distance of 18°, and bend the paper at this point to a right angle; then slide the measured part under the day circle, holding the other part against the face of it with the finger. This paper will thus measure the distance of 18° upon the globe, and the time during which the place is passing under it will be the length of twilight for that place.

The duration of twilight varies at different seasons of the year, at the same place. This is owing to the *direction* of the line of motion which the place takes when the globe rotates, after passing behind the day circle. When the line of motion maks a *right angle* with the day circle, twilight will be the *shortest*. The more *acute* the angle the *longer* will be the twilight.

The duration of twilight also varies according to the *situation* of the place, being *longest* at *high* latitudes. This is owing to the *decrease* in the *velocity* of the earth's *surface* as you move from the equator to the pole. All places which do not pass more than 18° behind the day circle, when the globe rotates, have twilight all night.

QUESTIONS.

At what time will evening twilight end, and morning twilight begin at Boston on 22nd of December? on the 10th of February? 21st of March? 10th of May? 22nd of June? At what time will twilight end or begin, on the above days, at New Orleans? Quito? Stockholm? London? At what season will there be twilight all night at Paris? at London? Edinburgh?

Diurnal, or clock time, varies at different places, according to the longitude of each, and is measured by the transit of the sun across the meridian of the place, the clock being then set at XII. Consequently clocks must vary in their time accordingly as they are situated east or west from each other. Therefore, when you have the time of any place given, and wish to determine the time of any other place, a means will be found by consulting

PROBLEM X.

The time of day being given at any place to determine the time at any other place.

Place the calendar index at the 21st of March, and bring the place, at which the time is given, directly under the day circle, and set the dial index to a figure on the inner circle corresponding to the given time. Then bring the place, at which the time is required, under the same side of the day circle, and read its time from the figures on the dial. It will be observed that if a place be situated *east* of a given meridian, its time will be *later* than at that meridian; if situated *west*, it will be *earlier*.

QUESTIONS.

When it is XII o'clock at Boston, what will be the time at New Orleans? at San Francisco? Canton? Cairo? London? When it is X o'clock at Washington what will be the time at New Orleans? at Halifax? Sandwich Islands?

There are 365 days in a year, but as the earth's *diurnal* and *annual* motions are in the *same direction*, it requires 366 revolutions of the earth upon its axis, to make 365 days. This may be illustrated by

PROBLEM XI.

To show why 366 *revolutions of the earth upon its axis are required, to make* 365 *days.*

In order that this problem may be more readily understood, it will be necessary to divide the year into larger parts than days, therefore *suppose* it to be divided into twelve parts, each part being one month long, and representing a day, or the time during which the globe shall make one revolution on its axis.

Now place the calendar index at the beginning of any month, and bring the graduated meridian of longitude directly under the sun, and set the dial index at XII; then move the calendar index forward one month, and it will be seen that had the globe made but one revolution on its axis, as indicated by the dial index, the same meridian would not have come under the sun, by a space of 30°. As this loss has occured in the space one month or thirty days, it is evident that it loses about one degree for every day; consequently, in order to complete a day, you must turn the globe once round upon its axis and about 1° more, or 1-365 part of another revolution. The difference between turning the globe *once* upon its axis, and turning it until the meridian comes directly *under* the sun, represents the difference between what is called *siderial* and *solar* time; *siderial* being measured by the transit of a *star* across the meridian of a place, and *solar* by the transit of the *sun*. Thus we have 366 siderial to 365 solar days.

The meaning of the "sun's being in any sign of the zodiac," and how to find when it will be there, may be illustrated by

PROBLEM XII.

To show the sun's place in the zodiac, and to find when it will be in any given sign.

If you place a lamp upon a table in the centre of a room and walk round it, the lamp will *appear* to move round on the opposite wall. The same phenomena occurs in the earth's motion round the sun, the latter *appearing* to move, among the stars, quite round the heavens in a year. This *apparent* path of the sun, embracing a space of 16° in breadth, is called the *zodiac*, and is divided into twelve parts, of 30° each, which are called *signs*, each having a particular name and character by which it is designated. The names of the twelve signs, with the time of the sun's entrance into them, are as follows:

1. Aries, or the Ram; March 21st.
2. Taurus, or the Bull; April 20th.
3. Gemini, or the Twins; May 21st.
4. Cancer, or the Crab; June 22nd.
5. Leo, or the Lion; July 23rd.
6. Virgo, or the Virgin; August 23rd.
7. Libra, or the Balance; September 23rd.
8. Scorpio, or the Scorpion; October 23rd.
9. Sagittarius, or the Archer; November 23rd.
10. Capricornus, or the Goat; December 22nd.
11. Aquarius, or the Waterman; January 20th.
12. Pisces, or the Fishes; February 19th.

The first six are called the *northern* signs, lying on the north side of the equator; and the last six, *southern*, lying on the south side.

The signs of Capricornus, Aquarius, Pisces, Aries, Taurus, and Gemini, are called *ascending*, because the sun approaches our north pole, while it passes through them; and Cancer, Leo, Virgo, Libra, Scorpio, and Sagittarius, are called *descending*, the sun receding from our pole, as it passes through them. This path of the sun, or zodiac, is represented upon the base of the globe, with its corresponding names and characters. By moving the globe round the sun, the *apparent* place of the latter in the zodiac, will be represented by the calendar index, which will also point to the corresponding time of the year.

As many persons do not know how the immense distances between the earth and sun, or stars, are measured, it will be necessary, in order that this may be readily understood, to explain a mathematical principle connected with it. In every triangle there are *three sides* and *three angles*; if *two* of the sides and the *included* angle be known, or if *two angles* and the *included side* be given, all the other sides and angles may be found by rules of trigonometry. The method of measuring the distance between two points, is by making a *third point* at a *known distance* from the *first point*, thus making a triangle, and measuring the angles at the *first* and *third* points, by which you will have *two angles* and the *included* side, from which the other parts of the triangle may be found.

Suppose it is required to measure the distance to a fixed star; we measure the angle included between lines drawn from the centre of the earth to the sun, and to the star; and then in six months from this time, or when the earth is at an opposite point of its orbit, measure the angle between the sun and star as before. The diameter of the earth's orbit being known, we have a triangle, *one* side, and *two adjacent* angles of which are known, and hence by rules of trigonometry, we can find the other sides which will give the required distance to the star.

This may be illustrated by

PROBLEM XIII.

To show the principle of measuring distances to the sun and stars.

Place the globe on a table, and select some object at the opposite side of the room, as a point to represent a star whose distance is to be measured. Now bring the globe to that part of its orbit at which it will be at right angles to a line drawn from the sun to the object or star, and *suppose* the angle that is formed by lines drawn from the centre of the globe to the sun and to the star to be measured by an astronomical instrument. Then move the globe round to the *opposite* side of the sun, and suppose the angle there to be measured in the same manner.

Now the diameter of the earth's orbit being known, it will form one side of the triangle, and having measured the two adjacent angles, all the other parts can be found.

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